

# Living Shorelines & Green Infrastructure

## Resource List

### Purpose:

- The purpose of this document is to provide resources for people interested in implementing living shorelines or green infrastructure approaches (whether for climate change adaptation purposes, or otherwise.)

### Contents:

- I. Background Information: Living Shorelines and Green Infrastructure (page 1)
  - II. Nature-Based Strategies Which Ones Fit Best My Stretch of Shoreline? (page 3)
  - III. Case Studies (page 5)
  - IV. Design Guidelines (page 7)
  - V. Policies and Permits (page 7)
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## **1. Background Information: Living Shorelines and Green Infrastructure**

### *What are they?*

1. **Living Shoreline's Academy** provides resources to learn about living shorelines – what they are, how they are designed & constructed, and how they serve our coastal habitats and communities: [www.livingshorelinesacademy.org](http://www.livingshorelinesacademy.org)
2. **Restore America's Estuaries** provides a short video, research, trends, institutional barriers, and methods of living shorelines across the U.S.: <https://estuaries.org/?s=Living+Shorelines>
3. Living Shorelines: From Barriers to Opportunities; **Restore America's Estuaries**: <https://estuaries.org/wp-content/uploads/2019/02/Living-Shorelines-From-Barriers-to-Opportunities.pdf>
4. **NOAA Digital Coast** offers an intro to green infrastructure, tools to understand your landscape: <https://coast.noaa.gov/digitalcoast/topics/green-infrastructure.html>

### *What are the benefits and costs? (An overview)*

5. **NOAA** provides a brief background on benefits, costs, steps, and typical treatments of living shorelines: <https://www.fisheries.noaa.gov/insight/understanding-living-shorelines>
6. **Living Shoreline habitat blueprint** and Carolyn Currin, a NOAA Scientist, Diving Deeper Podcast: <https://www.habitatblueprint.noaa.gov/living-shorelines/>

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### *Why choose this approach? (Making the case)*

7. The time to start is now: How implementing natural infrastructure solutions can improve and protect our coasts; **Environmental Defense Fund**:  
<https://www.edf.org/sites/default/files/cunniff-shore-beach-magazine.pdf>
8. Coastal Ecosystems: A Critical Element of Risk Reduction by **Mark D. Spalding et al.**:  
**\*Published** <http://onlinelibrary.wiley.com/doi/10.1111/conl.12074/pdf>

### *How effective are they? (An overview)*

9. **NOAA's 'Green Infrastructure Effectiveness Database,'** an online database of literature sources containing information on the effectiveness of approaches to reduce the impacts of coastal hazards (e.g. sea level rise): <https://www.coast.noaa.gov/digitalcoast/training/gi-database>
10. Performance of Natural Infrastructure and Nature-based Measures as Coastal Risk Reduction Features, **Environmental Defense Fund**:  
[http://www.edf.org/sites/default/files/summary\\_ni\\_literature\\_compilation\\_0.pdf](http://www.edf.org/sites/default/files/summary_ni_literature_compilation_0.pdf)
11. Natural Defenses in Action: Harnessing Nature to Protect our Communities, **National Wildlife Federation**: [http://www.nwf.org/~media/PDFs/Global-Warming/Reports/NWF\\_Natural-Defenses-in-Action\\_Report.pdf](http://www.nwf.org/~media/PDFs/Global-Warming/Reports/NWF_Natural-Defenses-in-Action_Report.pdf)

### *Thinking Globally*

12. Nature-based Solutions to Address Global Societal Challenges; **International Union for Conservation of Nature**: <https://www.iucn.org/sites/dev/files/content/documents/2016-036.pdf>

### *Working with Homeowners*

13. Participatory Conservation of Coastal Habitats: **The Importance of Understanding Homeowners Decisions Making** to Mitigate Cascading Shoreline degradation: **\*Published** <https://onlinelibrary.wiley.com/doi/full/10.1111/conl.12114>

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## 2. Nature-Based Strategies: Which Ones Best Fit My Stretch of Shoreline?

### *Nationwide*

14. Guidance for Considering the Use of Living Shorelines (2015), **NOAA**:  
<https://coastalscience.noaa.gov/news/noaa-releases-guidance-for-the-use-of-living-shorelines/>
15. Visit **Systems Approach to Geomorphic Engineering (SAGE)**, from the **United States Army Corps of Engineers** to learn about developing hybrid engineering approaches that link 'soft' ecosystem-based approaches (green) with 'hard' infrastructure approaches (gray) to enhance the resiliency of our coastal communities & shorelines: **\*USACE Resource**  
<http://SAGEcoast.org/info/information.html> +  
[http://sagecoast.org/docs/SAGE\\_LivingShorelineBrochure\\_Print.pdf](http://sagecoast.org/docs/SAGE_LivingShorelineBrochure_Print.pdf)
16. **Environmental Defense Fund's** strategy's includes methods of risk reduction, suitable conditions, performance factors, evaluation metrics, design metrics here:  
[http://www.edf.org/sites/default/files/summary\\_ni\\_literature\\_compilation\\_0.pdf](http://www.edf.org/sites/default/files/summary_ni_literature_compilation_0.pdf)
17. Living Shoreline Site Suitability & Shorelines Best Management practices, and Story Maps, **Center for Coastal Resources Management, Virginia Institute of Marine Science**:  
[https://www.vims.edu/ccrm/outreach/living\\_shorelines/index.php](https://www.vims.edu/ccrm/outreach/living_shorelines/index.php) **\*Story Maps**
18. The **Federal Resource Management and Ecosystem Services Guidebook**, from the **National Ecosystem Services Partnership**, serves as a training manual that helps to streamline the management of ecosystem services throughout the country: <https://nespguidebook.com/>
19. Measures Guidebook for Flood and Storm Risk Reduction Projects: North America Risk Reduction and Resilience Priority (2017), **The Nature Conservancy**:  
[https://www.researchgate.net/publication/315065811\\_Measures\\_Guidebook\\_for\\_Flood\\_and\\_Storm\\_Risk\\_Reduction\\_Projects\\_North\\_America\\_Risk\\_Reduction\\_and\\_Resilience\\_Priority](https://www.researchgate.net/publication/315065811_Measures_Guidebook_for_Flood_and_Storm_Risk_Reduction_Projects_North_America_Risk_Reduction_and_Resilience_Priority)
20. **Naturally Resilient Communities** (a partnership of APA, ASCE, TNC, etc.)- Explore the different types of nature-based solutions: <http://nrcsolutions.org/>

### *San Francisco Bay Area*

21. **The Baylands Ecosystem Habitat Goals Update (BEHGU)** has recommendations by shoreline segment. Find the segment that corresponds with your jurisdiction, then take a look at the "Recommended Actions" for that segment, here (starting on page 118):

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<https://baylandsgoals.org/wp-content/uploads/2016/10/Baylands-Complete-Report-2016.pdf>

22. **The San Francisco Estuary Institute (SFEI)** has an inventory of the San Francisco Bay Shoreline to show the first, and second lines of defenses around the entire San Francisco Bay: <http://www.sfei.org/content/flood-infrastructure-mapping-and-communication-project>
23. **The San Francisco Estuary Institute (SFEI)** has done work to identify “Operational Landscape Units” around the SF Bay Region in their **Adaptation Atlas (2019)** which are planning units based on environmental factors: <http://www.sfei.org/news/multi-partner-project-create-placed-based-sea-level-rise-adaptation-strategies> \*Menu of Strategies for SF Bay Area Region, 2019
24. **San Francisco Bay Subtidal Goals Report** provides framework and approaches & conservation planning for the submerged areas of the Bay: [www.sfbaysubtidalgoals.org](http://www.sfbaysubtidalgoals.org) + <http://www.sfbaysubtidal.org/PDFS/Full%20Report.pdf>
25. **Marin County’s “BayWAVE”** effort: Adaptation Fact Sheets that list options of strategies with graphics: [http://scc.ca.gov/files/2015/11/Adaptation\\_Fact\\_Sheets.pdf](http://scc.ca.gov/files/2015/11/Adaptation_Fact_Sheets.pdf) \*Local government’s adaptation strategy options
26. **San Mateo County’s “SeaChange”** effort: starting on PDF page 246 of 272 lists all adaptation strategies to be considered, categorized by “Accommodate, Protect, Retreat” with case studies: [https://seachangesmc.org/wp-content/uploads/2018/03/All\\_Appendices\\_V4\\_Linked\\_Unfillable.pdf](https://seachangesmc.org/wp-content/uploads/2018/03/All_Appendices_V4_Linked_Unfillable.pdf)
27. **Best locations and techniques for native oyster and eelgrass restoration** to assess whether the reefs can provide physical benefits such as reducing wave action and protecting adjacent shorelines: [http://www.sfbaylivingshorelines.org/sf\\_shorelines\\_about.html](http://www.sfbaylivingshorelines.org/sf_shorelines_about.html)
28. **National Fish and Wildlife Foundation** Final report on the San Francisco Bay and Outer Coast Watersheds Assessment: <https://www.nfwf.org/coastalresilience/Documents/san-francisco-bay-and-outer-coast-watersheds-coastal-resilience-assessment.pdf>
  - a. **Coastal Resilience Evaluation and Siting Tool (CREST):**  
<https://resilientcoasts.org/#Download>

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## 3. Case Studies

### *California*

1. **The Nature Conservancy (TNC)'s Case Studies of Natural Shoreline Infrastructure in Coastal California (2017):** [https://coastalresilience.org/wp-content/uploads/2017/11/tnc\\_Natural-Shoreline-Case-Study\\_hi.pdf](https://coastalresilience.org/wp-content/uploads/2017/11/tnc_Natural-Shoreline-Case-Study_hi.pdf) \*Go-to case studies for CA

### *San Francisco Bay Area*

2. **San Francisco Bay Living Shorelines Project** is demonstrating the potential of establishing native eelgrass and oyster beds to protect the San Francisco Bay shoreline while creating biologically rich and diverse habitat that is resilient to changing environmental conditions: <http://scc.ca.gov/climate-change/climate-ready-program/san-francisco-bay-living-shorelines-project/> + [www.sfbaylivingshorelines.org](http://www.sfbaylivingshorelines.org)
3. **Baylands Ecosystem Habitat Goals Project:** [www.baylandsgoals.org](http://www.baylandsgoals.org) \*also above under **Section II**
4. **Save the Bay Restored Wetlands** – community-based restoration program: <https://savesfbay.org/impact/restored-wetlands>
5. **The Watershed Project:** Wild Shorelines – restoration of oyster habitat in the San Francisco Bay: <http://thewatershedproject.org/wild-shorelines/>

### *California*

6. Economic Analysis of Nature-Based Adaptation for Climate Change in Ventura, CA [https://www.conservationgateway.org/Pages/PageNotFoundError.aspx?requestUrl=https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/FINAL\\_C](https://www.conservationgateway.org/Pages/PageNotFoundError.aspx?requestUrl=https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/FINAL_C)

### *United States*

7. **Rebuild by Design**-take a look at cities initiative: <http://www.rebuildbydesign.org/our-work/city-initiatives>
8. **Florida** coast that is at the change point from marsh grass to mangroves: <http://news.wjct.org/post/living-shorelines-are-being-created-along-floridas-coast>
9. **PBS News Hour** provides a brief background on **Florida** reversing coastal erosion using oyster shells and marsh grass: <https://www.pbs.org/newshour/science/as-seas-rise-americans-use-nature-to-fight-worsening-erosion>

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10. Developing Alternative Shoreline Armoring Strategies: The Living Shoreline Approach in North Carolina, USGS: [https://pubs.usgs.gov/sir/2010/5254/pdf/sir20105254\\_chap10.pdf](https://pubs.usgs.gov/sir/2010/5254/pdf/sir20105254_chap10.pdf)
11. **Ecological Response and Physical Stability of Habitat Enhancements** Along an Urban Armored Shoreline: enhancements were a habitat bench and pocket beach: <https://www.sciencedirect.com/science/article/pii/S0925857413001407> \*Published
12. **Banking on Green:** A Look at How Green Infrastructure can Save Municipalities and Provide Money and Provide Economic Benefits community-wide: [https://www.asla.org/uploadedFiles/CMS/Government\\_Affairs/Federal\\_Government\\_Affairs/Banking%20on%20Green%20HighRes.pdf](https://www.asla.org/uploadedFiles/CMS/Government_Affairs/Federal_Government_Affairs/Banking%20on%20Green%20HighRes.pdf)
13. **Financing Natural Infrastructure for Coastal Flood Damage Reduction:** Learn how natural storm defenses such as coastal wetlands help reduce waves and storm surge, protecting people and property: <https://conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/FinancingNaturalInfrastructureReport.pdf>

### *International*

14. **100 Resilient Cities** around the world: <http://www.100resilientcities.org/#/-/>

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### 4. Design Guidelines

1. **Federal Highway Administration (FHWA) Nature-Based Solutions** Information (with **National Guidelines to be released in 2019**):  
[https://www.fhwa.dot.gov/environment/sustainability/resilience/ongoing\\_and\\_current\\_research/green\\_infrastructure/](https://www.fhwa.dot.gov/environment/sustainability/resilience/ongoing_and_current_research/green_infrastructure/) \*Federal Highway Administration resource
2. **United States Army Corps of Engineers (USACE) Engineering with Nature** (non-regulatory, but they are **working on International Design Guidelines to be completed in late 2019**):  
<https://ewn.el.erdc.dren.mil/>

### 5. Policies & Permits

#### *San Francisco Bay*

1. **Regional Water Quality Control Board**:  
[https://www.waterboards.ca.gov/sanfranciscobay/water\\_issues/programs/general\\_permits.html](https://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/general_permits.html)
2. **Bay Conservation and Development Commission (BCDC)**: <http://www.bcdc.ca.gov/permits/>
3. Policy Perspective: **Coastal Ecosystems a Critical Element of Risk Reduction**  
<https://onlinelibrary.wiley.com/doi/pdf/10.1111/conl.12074> \*Published
4. **US Army Corps of Engineers (USACE) San Francisco District**:  
<https://www.spn.usace.army.mil/Missions/Regulatory/How-to-Apply-for-a-Permit/>

#### *California*

5. Stanford's Center for Ocean Solutions recently produced **policy briefs for Coastal Adaptation Strategies**, and includes policy briefs for Financial and Legal & Regulatory adaptation approaches, the Public Trust Doctrine, Louisiana Sea Grant:  
<http://centerforoceansolutions.org/coastal-adaptation-policy-briefs> \*Go-To Resource
6. **California Fish and Wildlife**: <https://www.wildlife.ca.gov/>

#### *United States*

5. **Management, Policy, Science and Engineering of Nonstructural Erosion Control in the Chesapeake**:  
[https://www.vims.edu/cbnerr/docs/ctp\\_docs/ls\\_docs/06\\_LS\\_Full\\_Proceed.pdf](https://www.vims.edu/cbnerr/docs/ctp_docs/ls_docs/06_LS_Full_Proceed.pdf)
6. "Permitting a Living Shoreline: A Look at the Legal Framework Governing Living Shoreline Projects at the Federal, State, and Local Level" & "Exploring Living Shorelines Permitting" – Boyd et al., **Louisiana Sea Grant**: <https://www.laseagrant.org/>